

UNPUBLISHED PRELIMINARY DATA

Semi-annual Progress Report for Period 10/1/64 to 4/1/65NASA Grant NsG-646 (Analog/hybrid Computer Study)

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1. ASTRAC II Project

Reference is made to the review of the ASTRAC II project presented in our status report of November 20, 1964 (ACL Memo No. 96). ASTRAC II, scheduled for full completion in September, 1965, began to compute in late October, 1964, and has solved modest nonlinear as well as linear test problems (Van der Pol's differential equation, circle test). Circle-test data yielded measured phase-shift errors of 0.08 per cent for an ASTRAC II integrator and 0.16 per cent for a phase inverter with 16 Kc sinusoidal input; this is just the figure predicted by theory for 20 Mc amplifiers with 6 db/ octave rolloff. The attainment of such computing speeds with a standard shielded analog-computer patchbay bears out the soundness of the low-impedance design used in ASTRAC II.

The main technical problem to be overcome is to minimize digital-computer noise in analog computing elements and ground system. To tackle this problem, which is common to all hybrid analog-digital computer systems, we are taking the following measures:

1. Install analog and digital computing elements in separate shielded bays.
2. Feed analog and digital power supplies from separate power-line phases, with all power lines in shielded conduits, and RF filters in each power line.
3. Digital-signal lines to and from the analog-computer bay will be twisted, shielded low-capacitance lines, with the ground return shielded. This will also minimize pickup of

of line-frequency harmonics.

Digital as well as analog computer patchbay has been wired; the last 20 of 40 amplifiers and 18 mode-control switches will be delivered before May 1. A new convenient power-supply-monitor panel was designed and will permit continuous monitoring of the critical $\pm 10V$ and $\pm 15V$ balance as well as pushbutton connections of analog power-supply voltages to the main digital-voltmeter bus. We are attempting to complete enough of the machine to permit simple demonstrations at the May 21 Simulation Council meeting in Tucson.

2. COMPONENT DEVELOPMENT

R. Whigham completed development of the ASTRAC II analog comparator. Tested in the computer, the prototype switched within 100 nsec of zero-crossing for all input-signal slopes between 0 and 5×10^6 volts/sec. Static hysteresis between $\pm 10mV$ and $\pm 40mV$ improves noise immunity. Drift (referred to input) is less than $25\mu V/deg\ C$ without chopper stabilization, which is optional.

3. OTHER ACTIVITIES

P. O'Grady is experimenting with an iterative-parameter-optimization scheme which measures gradient components through crosscorrelation between criterion function and parameter perturbation in the form of shift-register noise. G.A. Korn completed reports on the effects of quantization on statistical measurements and on proposed Monte-Carlo computation combining ASTRAC II and a small digital computer.

4. PUBLICATIONS

The following report were completed during the subject grant period:

1. Whigham, R. H. : A Hybrid-code Multiplier, ACL Memo No. 104, October, 1964.

2. _____: A Fast $\pm 10V$ Quarter-square Multiplier (M.S. Thesis), ACL Memo No. 88, February, 1965; submitted to Simulation.
3. _____: ASTRAC II Plug-in Diode Function Generator, ACL Memo No. 101, February, 1965.
4. _____: A Fast Comparator for Hybrid Computation, ACL Memo No. 95, March, 1965; submitted to IEEEETEC.
5. Eckes, H. R. : A Fast Electronic Mode-Control Switch for Integrators and Track-hold Circuits, ACL Memo No. 107, March, 1965, submitted to IEEEETEC.
6. Korn, G. A. : Statistical Measurements with Quantized Data, ACL Memo No. 102; published in Simulation, April, 1965.
7. _____: Hybrid-computer Monte-Carlo Techniques, ACL Memo No. 109, March, 1965; invited symposium paper for IFIP Congress, New York, May, 1965. The following ACL publications, although not supported by the NASA/AFOSR grant, were completed during the report period:
8. Sager, W. J. : A One-amplifier Triangle-averaging Multiplier, ACL Memo No. 112, February, 1965.
9. Korn, G.A. : Report on the 4th AICA Conference, Brighton, England, 1964, and Pre-conference visits, Simulation, November, 1964.
10. _____: The Electrical Engineering Department Analog/Hybrid Computer Laboratory, ACL Memo No. 113, March, 1965; to be published in Simulation, 1965.